by Andrew Bernard, Stephen Redding,
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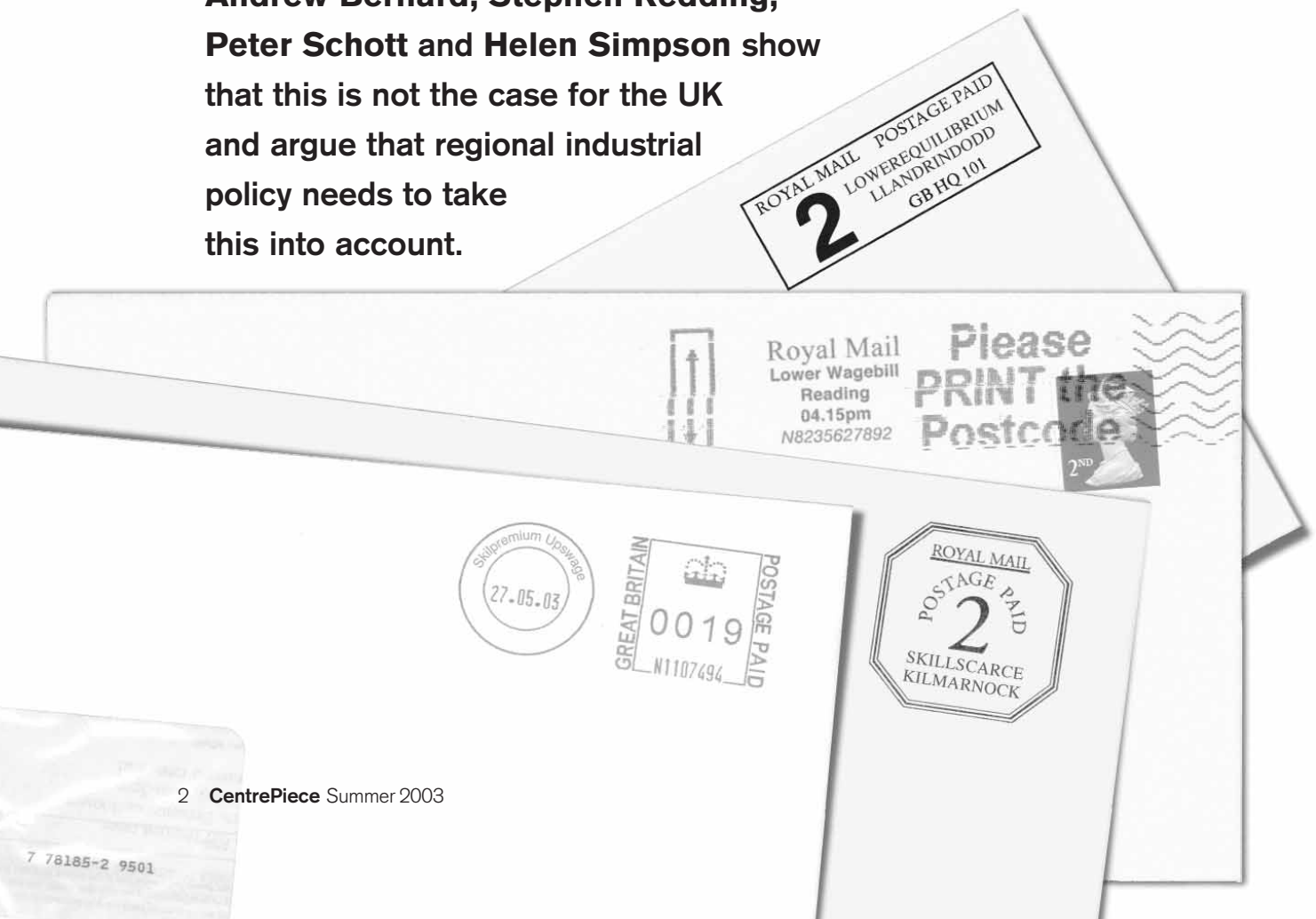
All is not equal

Theory suggests that market forces should bring the relative pay of skilled workers into line in different regions within a country. Andrew Bernard, Stephen Redding, Peter Schott and Helen Simpson show that this is not the case for the UK and argue that regional industrial policy needs to take this into account.



Wage variations are critical for firms in choosing where to locate, for workers in deciding where to live and for governments in managing regional development.

Economic theory suggests that capital mobility, worker migration and goods trade should be powerful mechanisms in promoting the convergence of factor prices. Because the operation of these forces is more powerful within countries than between them, such convergence seems more likely to occur within an economy than internationally.

It is surprising, therefore, that research we have done suggests that there are in fact large differences in skill premia in wages between different regional labour markets in the UK. This is despite the fact that the UK is a relatively small geographic area with high population density, characteristics that should strengthen the forces producing factor price convergence. Our results suggest that relative wages for skilled workers are one third lower in the South-East than in Wales or Scotland.

The research also finds that differences in the relative return for skilled workers correlate to variations in industrial structure between regions. Regions showing more divergent relative wages are regions with fewer industries in common. This finding fits with what economists know as the Heckscher-Ohlin factor proportions theory, which suggests that countries (or regions within countries) specialise in industries on the basis of comparative advantage in relative factor endowments.

These findings have important implications for regional responses to globalisation.. Regions within advanced countries may be differentially affected by the increased import competition from low-wage countries resulting from globalisation, depending on whether they produce low- or high-skilled labour intensive products. This relates directly to debates about regional policies designed to attract skill-intensive industries to regions with high levels of unskilled labour.

Factor price equality can be either absolute or relative. Where there is absolute factor price equality, regions producing identical products for identical prices with identical technologies must have identical nominal factor rewards at any given point in time. Where there is relative factor price equality, regions producing identical products for identical prices must have identical relative factor rewards, even though absolute factor prices may differ. We focus here on relative factor price equality.

Empirical testing for factor price equality can be both direct and indirect. Direct tests examine whether raw or adjusted factor prices are equal between regions within countries, or between countries themselves. Indirect tests, typically based upon the Heckscher-Ohlin trade model, infer the existence of factor price equality from the distribution of economic activity. If factors of production are immobile between regions or countries, production is physically located according to comparative advantage. If relative factor prices differ, regions with a lot of skilled labour will have relatively low skill premia and attract skill-intensive industries, while regions with a lot of unskilled labour will have high skill premia and, therefore, be more attractive to unskilled labour-intensive industries.

In our study we used a direct test of factor price equality developed by two of us (Andrew Bernard and Peter Schott) for the United States in 2001. This methodology emphasises the importance of unobserved variation in factor quality, which cannot be directly measured and which biases traditional wage measures. If unobserved factor quality varies between regions, observed wages will also generally vary, even if true quality-adjusted wages are the same. The Bernard-Schott test uses total payments to each factor (e.g. wage bills for payments to labour) to control for this potential unobserved regional variation in factor quality. Besides applying this wage bill test to the United Kingdom, we demonstrate theoretically how it can identify departures from factor price equality under a more general set of assumptions than originally considered, including imperfect competition, increasing returns to scale, and variation in both the quality and composition of factors across regions and industries.

Our data source was the United Kingdom's Annual Respondents Database (ARD). This dataset includes a variety of information on production activity in manufacturing establishments. It allows labour to be broken down into two categories: Administrative, Technical and Clerical Workers (i.e. non-production workers); and Operatives (i.e. production workers). Following standard practice, we have taken non-production and production workers to represent high- and low-skill workers respectively. Our test explicitly controls for variation in the quality and composition of these two groups of workers.

Each ARD establishment can be associated with one of some 200 four-digit industries. The disaggregated level at which production is recorded is an advantage for our analysis as it mitigates the possibility that a departure from relative factor price equality is due to unobserved variation of product mix within an industry.

We examined variation in relative wages, employment and wage bill levels at two levels of geographical disaggregation. First, we considered the 10 administrative regions of Great Britain. Second, we examined variation between the more than 100 postcode areas. (We took the eight Central London postcode areas as a single region, reflecting commuting patterns.)

We took 1992 as our baseline, but as a robustness test we also show results for 1986. Persisting differences between UK regions in quality adjusted relative wages for two years

Relative wages for skilled workers are one third lower in the South-East

Table 1. Estimations for administrative regions on UK base

1992		
Administrative Region	**Coeff**	**p-value**
South-East	0.263	0.000
South-West	0.067	0.171
East Anglia	-0.044	0.415
North-West	-0.086	0.056
East Midlands	-0.091	0.049
West Midlands	-0.069	0.134
Yorkshire	-0.098	0.033
Northern	-0.172	0.001
Wales	-0.187	0.000
Scotland	-0.182	0.000
F-stat. (p-value)		0.000
Observations		1440

1986		
Administrative Region	**Coeff**	**p-value**
South-East	0.226	0.000
South-West	-0.072	0.123
East Anglia	-0.047	0.343
North-West	-0.044	0.290
East Midlands	-0.067	0.121
West Midlands	-0.086	0.048
Yorkshire	-0.109	0.011
Northern	-0.309	0.000
Wales	-0.120	0.010
Scotland	-0.145	0.001
F-stat. (p-value)		0.000
Observations		1413

Estimates based on pooling 4 digit industries and regions, taking the UK as a whole as the base region. p-values are heteroscedasticity robust.

that were at such different stages of the business cycle would be strong evidence of systematic deviations from relative factor price equality that were not driven by idiosyncratic shocks to particular regions or by business cycle fluctuations.

Because individual establishments are subject to idiosyncratic shocks, measurement error in establishment-level data may be large for any one year. So we aggregated establishments to produce data for industries in each region. We excluded all industries classified as "Other Manufacturing", since these are explicitly heterogeneous categories that may include different sub-industries in different regions.

From our regression analysis, Table 1 shows estimated differences, using the whole UK as the base, in log relative wage bill ratios for Administrative Regions in 1992 and 1986. For both years it is clear that relative factor price equality between regions did not exist.

Whether the estimated values of the dummies correspond to higher or lower quality-adjusted relative wages for skilled workers depends on the production technology involved. With a constant elasticity of substitution (CES) production technology, a positive coefficient corresponds to a lower quality-adjusted relative skilled wage where the elasticity of substitution between skilled and unskilled workers is greater than one. (This is the typical case found in the labour economics literature.)

Table 2 gives the implied quality-adjusted relative skilled wages for an elasticity of substitution of two in 1992. It shows that the most skill-abundant region (the South-East, which includes London) has a lower equilibrium value of the relative wage of skilled workers, while skill-scarce regions

Table 2. Actual and implied quality-adjusted relative wage differences (CES Technology)

1992		
Administrative Region	**Actual**	**Quality-adjusted** $\sigma = 2$ $\rho = 0.5$
South-East	0.97	0.77
South-West	0.99	0.94
East Anglia	0.99	1.05
North-West	1.00	1.09
East Midlands	0.93	1.10
West Midlands	1.00	1.07
Yorkshire	1.00	1.10
Northern	1.07	1.19
Wales	1.06	1.21
Scotland	1.01	1.20

Actual relative wages are means across 4 digit industries within region relative to the UK average. Coefficients used to evaluate quality-adjusted relative wage differences are from Table 1, based on pooling 4 digit industries and regions, taking the UK as a whole as the base region.

Wales and Scotland tend to have higher relative skilled wages

Table 3. Postcode areas with positive and significant coefficients on UK base
Positive and Significant Region Coefficients at the 10% Level

1992			1986		
Postcode Region	**Coeff** ρ **= 0.5**	σ**= 2**	**Postcode Region**	**Coeff** ρ **= 0.5**	σ**= 2**
Slough	0.195	0.82	Reading	0.187	0.83
Twickenham	0.236	0.79	Enfield	0.201	0.82
Swindon	0.237	0.79	Guildford	0.208	0.81
Hemel Hempstead	0.244	0.78	Swindon	0.283	0.75
Kingston	0.247	0.78	Slough	0.303	0.74
Redhill	0.271	0.76	Hemel Hempstead	0.311	0.73
Cambridge	0.298	0.74	Sutton	0.623	0.54
St Albans	0.364	0.69			
Sutton	0.559	0.57			
F-stat. (p-value)		0.00	F-stat. (p-value)		0.00
Observations		5044	Observations		5027

Notes: Coefficients based on pooling 4 digit industries and postcode areas, taking the UK as a whole as the base region. Listed regions have statistically significant positive coefficients at the 10% level. p-values are heteroscedasticity robust.

Table 4. Postcode areas with negative and significant coefficients on UK base
Negative and Significant Region Coefficients at the 10% Level

1992			1986		
Postcode Region	**Coeff** ρ **= 0.5**	σ**= 2**	**Postcode Region**	**Coeff** ρ **= 0.5**	σ**= 2**
Llandrindod Wells	-0.669	1.95	Dumfries	-0.504	1.66
Dumfries	-0.530	1.70	Aberdeen	-0.433	1.54
Chester	-0.432	1.54	Cleveland	-0.366	1.44
Galashiels	-0.392	1.48	Sunderland	-0.364	1.44
Watford	-0.364	1.44	Plymouth	-0.330	1.39
Sunderland	-0.357	1.43	Blackpool	-0.327	1.39
Exeter	-0.350	1.42	Cardiff	-0.322	1.38
Llandudno	-0.344	1.41	Kilmarnock	-0.319	1.38
Aberdeen	-0.322	1.38	Truro	-0.306	1.36
Peterborough	-0.285	1.33	Newcastle	-0.296	1.34
Plymouth	-0.282	1.33	Llandudno	-0.293	1.34
Durham	-0.260	1.30	Canterbury	-0.276	1.32
Doncaster	-0.249	1.28	Darlington	-0.273	1.31
Cleveland	-0.239	1.27	Wolverhampton	-0.252	1.29
Sheffield	-0.236	1.27	Wakefield	-0.251	1.29
Kilmarnock	-0.234	1.26	Halifax	-0.245	1.28
Cardiff	-0.221	1.25	Bradford	-0.231	1.26
Crewe	-0.218	1.24	Bath	-0.220	1.25
Walsall	-0.197	1.22	Sheffield	-0.210	1.23
Dudley	-0.190	1.21	Wigan	-0.208	1.23
Manchester	-0.171	1.19	Motherwell	-0.207	1.23
Wolverhampton	-0.167	1.18	Oldham	-0.200	1.22
Newport	-0.152	1.16	Nottingham	-0.188	1.21
			Carlisle	-0.185	1.20
			Walsall	-0.185	1.20
			Hull	-0.181	1.20
			Dudley	-0.174	1.19
F-stat. (p-value)		0.00	F-stat. (p-value)		0.00
Observations		5044	Observations		5027

Bilateral comparisons of production overlap and estimated differences in relative wage bills for 111 Postcode Areas. Dependent variable is the number of industries produced in both region r and region s. Independent variables are the absolute value of the estimated difference in relative wage bills from equation (23) (?(rs)); the number of industries produced in region r; and the number of industries produced in region s. p-values are heteroscedasticity robust.

These findings have important implications for regional responses to globalisation

(such as Wales and Scotland) have higher equilibrium values of the relative skilled wage. For comparison, Table 2 also shows regions' average observed relative skilled wages, expressed as a ratio of the average for the UK as a whole. Even looking at observed relative wages, we find that the South-East tends to have a lower relative skilled wage, while Wales and Scotland tend to have higher relative skilled wages.

The differences in actual relative wages are smaller than those in quality-adjusted relative wages, implying that the relative quality of non-production (or skilled) workers is higher in the South-East than in Wales or Scotland.

Results for postcode areas are presented in Tables 3 and 4. Again, it is clear that relative factor price equality did not exist in either 1986 or 1992. In 1992, at the 10% statistical significance level, nine postcode areas were above zero and 23 were below. Those above zero are concentrated in the South-East, to the M25 and the M4 corridor, and in the area around Cambridge (see Figure 2).

Results for 1986 display a similar pattern: seven regions are above zero and 27 below. Four of the postcode areas above zero in 1986 are in the same 1992 list. The emergence in 1992 of Cambridge as a high relative wage bill region is consistent with the recent development of IT and biotechnology industries in the area.

Tables 3 and 4 also give the implied quality-adjusted relative wages for an elasticity of substitution of two. Figures 1 and 2 display the geographical distribution of the estimated coefficients in 1992 for administrative regions and postcode areas respectively. They distinguish between three groups of regions: those with positive and statistically significant coefficients representing regions with relatively low skill premia (indicated by the dark shading); those with negative and significant coefficients representing regions with relatively high skill premia (indicated by the intermediate shading); and those with no statistically insignificant coefficients (indicated by light or no shading). Both Figures show a clear concentration of regions with positive estimated values (low quality-adjusted skill premia) in the South-East.

Let us now look at some possible explanations for these striking results. If regions start with sufficiently different endowments so that, in line with the Heckscher-Ohlin factor proportions theory, they come to specialise in distinct industries, and if at least one type of labour involved displays a degree of geographical immobility, then quality-adjusted regional relative factor prices will vary. Immobility for one type of labour will prevent regional factor prices (and endowments) from converging towards a common value across the country. There is a substantial body of empirical evidence suggesting that labour mobility between UK regions is relatively low.

A central prediction of the Heckscher-Ohlin model is that the skill premium between two regions specialising on the basis of comparative advantage is inversely proportional to the level of skill endowments. Our estimates of quality-adjusted relative wages in Table 2 exhibit just such results. For realistic estimates of the elasticity of substitution between production and non-production workers, we find the skill premium to be lower in the regions around London, where skilled labour is relatively abundant, and higher in outlying areas, where skilled labour is relatively scarce.

The Heckscher-Ohlin model has an additional empirical implication. Regions with different skill premia should exhibit systematic differences in production structure, with skill-abundant regions producing a set of goods that is more skilled labour intensive than unskilled-abundant regions. We examined this additional prediction by comparing the similarity of industry structure between regions. In general equilibrium, regions with fewer industries in common should have larger differences in relative factor prices.

Table 5 presents the results of estimating this relationship for postcode areas. We found that larger differences in

Figure 1. Administrative regions' estimated coefficients, 1992 (10% significance)

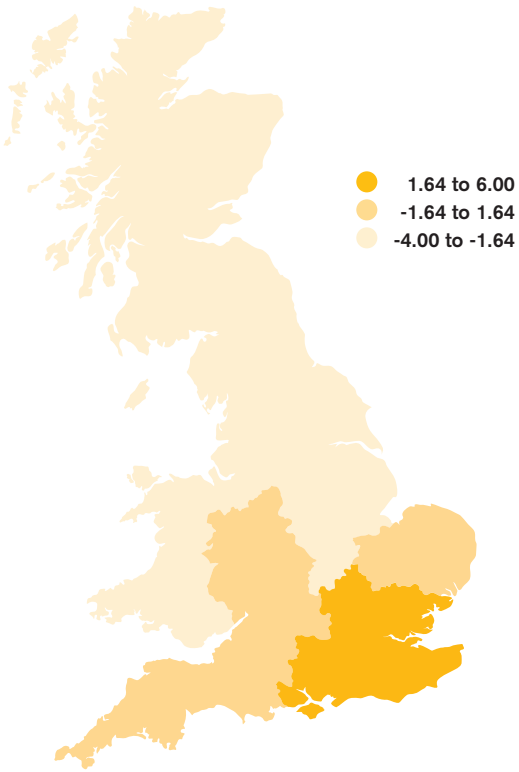
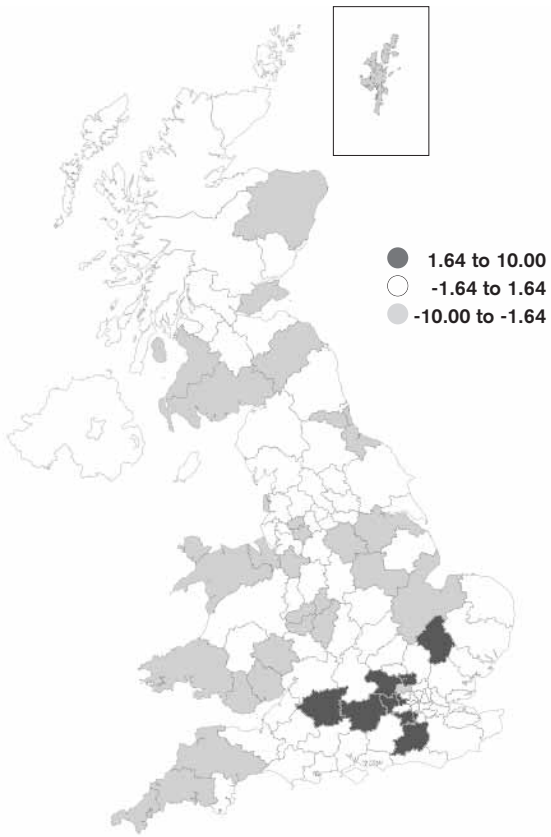


Table 5. Relative wage differences and industrial structure

	1992		1986	
	Coeff	p-value	Coeff	p-value
Dependent Variable = Number of industries in r and s				
Abs Wage Bill Coeff	-1.208	0.000	-0.983	0.000
Industries in r	0.304	0.000	0.305	0.000
Industries in s	0.308	0.000	0.320	0.000
Constant	-11.384	0.000	-11.732	0.000
Obs		6105		6105
F-stat. (p-value)		0.000		0.000
R-squared		0.83		0.84

Bilateral comparisons of production overlap and estimated differences in relative wage bills for 111 Postcode Areas. Dependent variable is the number of industries produced in both region r and region s. Independent variables are the absolute value of the estimated difference in relative wage bills from equation (23) (?(rs)); the number of industries produced in region r; and the number of industries produced in region s. p-values are heteroscedasticity robust.

Figure 2. Postcode areas' estimated coefficients, 1992 (10% significance)



relative factor prices across regions are indeed associated with greater differences in industrial structure.

Taken together, our findings suggest that variation in relative factor prices plays an important role in shaping firms' location decisions within the UK. Evidence of systematic differences in industrial structure linked to relative factor prices implies that external shocks may affect UK regions asymmetrically.

This evidence is also important to policy debates about the role of regional policies designed to attract skill-intensive industries to unskilled labour abundant regions. A clearer understanding of the character of regional industrial variation within the UK can inform the growing policy interest in this subject in the context of developing political devolution.

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